Summer 2019

Making a Tiger's Day: Free-Operant Assessment and Environmental Enrichment

Trista Yvonne Shrock
Missouri State University, Trista1991@live.missouristate.edu

MAKING A TIGER'S DAY: FREE-OPERANT ASSESSMENT AND ENVIRONMENTAL ENRICHMENT

A Master's Thesis

Presented to

The Graduate College of

Missouri State University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Applied Behavior Analysis

By

Trista Shrock

August 2019

MAKING A TIGER'S DAY: FREE-OPERANT ASSESSMENT AND ENVIRONMENTAL ENRICHMENT

Psychology

Missouri State University, August 2019

Master of Science

Trista Shrock

ABSTRACT

Problem behaviors occur often in captive wild animals due to stress and boredom. Environmental enrichment is one of the most successful methods to help minimize these types of behaviors in many captive wild animals. The current study investigated preferences of play items and scents for seven adult Bengal tigers in a Tiger Sanctuary using a free-operant preference assessment. Two subspecies of Bengal tiger (*Panthera tigris*) are represented. Six of the tigers are *Panthera tigris tigris* and one is *Panthera tigris altaica*. Three phases were run on each tiger, ultimately establishing a hierarchy of preferred play items and scents for each tiger included in the study. The significance of systematic manipulation of play items and scents (preference testing) with wild animals is discussed as well as the importance of caring for captive animals.

KEYWORDS: environmental enrichment, Bengal tigers, free-operant, preference assessment, olfactory stimuli

MAKING A TIGER'S DAY: FREE-OPERANT ASSESSMENT AND ENVIRONMENTAL ENRICHMENT

By

Trista Shrock

A Master's Thesis
Submitted to the Graduate College
Of Missouri State University
In Partial Fulfillment of the Requirements
For the Degree of Master of Science, Applied Behavior Analysis

August 2019

Approved:

Michael Clayton, Ph. D

D. Wayne Mitchell, Ph. D

Tanya Whipple, Psy. D

Julie Masterson, Ph. D., Graduate Dean

ACKNOWLEDGEMENTS

This research was supported by the Missouri State University Graduate College. I would also like to thank my advisor, Dr. Michael Clayton for his continued guidance and support throughout this project and my Graduate process as a whole, for the many times I came rushing to his office in a near panic for small issues; thank you for keeping me sane. Thank you also, to my committee members Dr. Mitchell and Dr. Whipple for your insight, your flexibility and your faith in my project. I would also like to thank the National Tiger Sanctuary for allowing me to conduct my research there with these wonderful animals.

Finally, I want to thank my parents, Owen Shrock, and Nick and Lila Woollums for their unconditional love and support throughout my graduate studies. As well as my best friends, Annemarie Careccia, Sam and Rachel Porter; my boyfriend, Landon Goodwin, and my mentor, AmyRose Tomlinson for their unwavering support throughout this journey. For all the sleepless nights, cancelled plans, “one-more-minute” moments and unanswered texts, thank you for believing in me and being my biggest cheerleaders.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

There was once an abundance of wild tigers in the world, including nine subspecies, spread across 13 countries (World Wildlife). In 1998, an estimated 7,000 tigers remained in the wild, and by 2010, the population of wild tigers had decreased to 2,154. Today, it is estimated that there are 3,159 tigers remaining (ICUN Red List). In this case, "population" is defined as "the number of mature individuals estimated or inferred to be capable of reproduction" (IUCN Standards and Petitions Subcommittee 2010). These declines in number are due to high levels of poaching as well as habitat destruction (Karmacharya et al., 2018). Of the nine subspecies of tigers, there are now only six remaining and only five of those subspecies are represented in the wild. Tigers, as a species, are now considered endangered and facing extinction (Narayan et al., 2013a). Their captivity is now vital to keeping tigers, as a species, alive, and necessary if reintroduction into the wild can ever take place. Given the large proportion of tigers in captivity, it is important to do everything necessary to ensure they are happy and well-adjusted, if extinction is to be avoided.

Wildlife being kept in captivity is not a recent undertaking. One motive for the practice of catching and displaying wild animals in cages is for entertainment and profit (Fudge, 2005). Another motive is to protect what is left of a species on the brink of extinction (e.g., rhinoceros, tigers). Many zoo programs often specialize in the breeding and reintroduction of endangered species back into the wild (Gilbert et al., 2017). One consequence of captivity for many wild animals is an increase in problem or stereotypic behaviors (Vaz et al., 2017). The best way to minimize these problem behaviors is to enrich the animals' lives with physical and mental stimulation (Marquez-Arias et al., 2010). Historically speaking, captive wild animals have been

kept in enclosures that were restrictive and without stimuli that is often found in nature (Mench & Kreger, 1996).

Literature exists on the effects of captivity on animal welfare (Carlstead, 1996), as well as ways of enriching the environments of wild animals held in captivity. Environmental enrichment methods range from making the animal's environment similar to their natural environment to administering psychoactive drugs in order to reduce problem behaviors. Probably the most successful of these methods is environmental enrichment (Marquez- Arias et al., 2010). Environmental enrichment can be defined as "any addition to the environment of an animal resulting in a presumed increase in the environments quality, and a subsequent presumed improvement to the animal's welfare" (Ellis, 2013).

The term 'enrichment' itself covers a very wide array of different types of objects that are used to enhance animal welfare in captivity (Marquez-Arias et al., 2010). The objects used vary among species of animals and even in sub-species of the same species of animal. Enrichment can include food items, items for the animal to play with, olfactory stimuli, auditory enhancements, as well as many kinds of small adjustments to the animal's living environment. While some of the more popular types of enrichment are food and toys, scents and odors can also play a large role in how the animals respond. Olfactory stimuli are used as a primary means to find prey in the wild, as well as having a psychological effect on the animals giving cues on reproduction quality and maintaining territories (Soso et al., 2014). Something as small as a scent being added to an enclosure can alleviate boredom in captive wild animals (Powell, 1995).

Although animal welfare is the primary concern when it comes to the need for enrichment, positive changes in an animal's behavior as a result of added enrichment items are also welcome. An animal with enrichment items is more likely to exhibit playful and naturalistic

behaviors, rather than aggressive or stereotypic behaviors (Makecha, & Highfill, 2017). This helps to enhance the experience that guests have when watching these animals in zoos, sanctuaries, and recorded documentaries as well. Not only does it enhance the experience, it also serves as a way to educate people on how these animals might act in the wild (Shepherdson, 1998). These enriched environments draw more attention and thus become more popular for tourists to visit. Visitors to zoos and animal parks are happier with their decision to visit when they feel the animals are being properly cared for and look relatively happy to be in captivity. (Mellen et al 1981). In recent years, there has been a call for more behavior analytic methodology in environmental enrichment research (Allisgood, Dorey, Mehrkam, & Leighty, 2016).

In order for an enrichment item to be as effective as possible, it is sometimes necessary to find ways to form a hierarchy of enrichment items for these animals. If an animal is only given mildly reinforcing enrichment, it is less effective than a more highly-preferred item would be (Fernandez et al., 2004). Preference assessments have proven to be an effective and generally simple way to create a hierarchy of preferred enrichment items in both humans and animals alike. Preference assessments have also been shown to reliably reduce abnormal or unwanted behavior in both humans and animals (Ringdahl et al., 1997).

Fernandez, Dorey, and Rosales-Ruiz (2004) used a two-choice food preference assessment with Tamarins and found great variation between animals but a general trend in preference for specific items. Mehrkam and Dorey (2014) studied the relationship between preference and enrichment efficacy in Galapagos tortoises (*Chelonoidis nigra*) and found that preference may be an efficient predictor of enrichment efficacy.

Ellis, Stryhn, Spears, and Cockram (2017) studied enrichment preference of domestic cats (*Felis catus*) using a choice chamber that also served as the cats' housing. They found that the cats preferred to hide more than be visible to visitors at the animal shelter. Shreve, Mehrkam, and Udell (2017) investigated domestic cat preferences at the individual and population level using a free-operant preference assessment. They found clear individual variability in cat preference, but that social interaction with humans was the most-preferred stimulus category for the majority of cats, followed by food.

Mehrkam and Dorey (2015) studied the utility of preference assessments across six common zoo animals and found that, regardless of experience, zoo personnel were more accurate at predicting least-preferred stimuli than most-preferred stimuli across species, and tended to make the same predictions for all individuals within a species. This suggests that trainers and staff understood better the things their animals disliked than they did the things their animals actually preferred. More significantly, they tended to generalize preferences from individuals to all members of a species.

Some scientists and authors believe that preference assessments are the best way to determine what will make an animal most pleased with an enrichment item of any type (Maia & Volpato, 2017). These preference assessments are given to adults and children with developmental and/or behavioral deficits. Like with humans, there is some debate over whether these momentary choice situations fairly represent individual animal preferences. (Maia & Volpato, 2017)?

The current study attempted to establish a hierarchy of tigers' preferred play items using a free-operant preference assessment in an animal sanctuary in southwest Missouri.

METHOD

Participants

Seven adult Bengal tigers participated in this study. Two subspecies of Bengal tiger (Panthera tigris) were represented. Six of the tigers were (*Panthera tigris tigris)* and one was (*Panthera tigris altaica)*. The tigers ranged in age from six- to 16-years-old and consisted of five females and two males.

Harry, a 6-year-old male, orange Siberian (*Panthera tigris altaica*) and Bengal (*Panthera tigris tigris*) hybrid, weighing approximately 550 pounds and who has lived at the Sanctuary for five years. Harry was previously part of the cub handling or 'pay for play' industry. Harry lives in his own enclosure with another tiger on one side and a pride of lions on the other side.

Farah, a 15-year-old female, white Bengal tiger (*Panthera tigris tigris)* weighing approximately 350 pounds and who has lived at the Sanctuary for 18 months. Farah was previously part of a breeding component of a facility that leased out tigers to circuses. Farah was one of the top breeders at the company and has had many litters of cubs. She lives in her own enclosure with other tigers on either side.

Dakar, a 6-year-old male, white Bengal tiger (*Panthera tigris tigris*) weighing approximately 500 pounds and who has lived at the Sanctuary for 18 months. Dakar was previously at the same breeding side of the leasing facility as Farah. He was not, however, old enough to breed while at the facility. Dakar lives in his own enclosure with another tiger on one side of his enclosure.

Carma, a 10-year-old female, white Bengal tiger (*Panthera tigris tigris*) weighing approximately 350 pounds and who has lived at the Sanctuary for just over one year and was

previously performing in the same industry as Farah and Dakar. Carma was the youngest performing tiger in that facility because she was meant to be a breeder but became violent when she was around male tigers. Because of this history, she underwent all of the standard training procedures that performing cats experience, including frequent use of punishment methods (e.g., whips).

Princess, a 13-year-old female, white Bengal tiger (*Panthera tigris tigris*) weighing approximately 350 pounds and who has lived at the Sanctuary for four years. Princess spent the prior years, before arriving at the sanctuary, living in a basement with no outside access and very little room to move. She was part of a magician's act in southwest Missouri. When Princess (as well as Stripey and Precious) arrived at the Sanctuary, it was the first time she had seen the sun or felt grass. Princess is the dominant tiger in her enclosure. She is the first to touch any enrichment item and receives her food first or she will act aggressively.

Stripey, a 16-year-old female, orange Bengal tiger (*Panthera tigris tigris*) is smaller than the average female Bengal tiger and weighs only about 275 pounds. Stripey is the most docile tiger in the enclosure she shares with Princess and Precious. Stripey is the last to touch enrichment items, preferring to wait until the other two are not around to disturb her. She is also very friendly toward humans and other tigers.

Precious, a 13-year-old female, white Bengal tiger (*Panthera tigris tigris*) is from the same litter as Princess and weighs approximately 350 pounds. Precious is cross-eyed and very friendly toward humans. She was from the same magician's act in southwest Missouri as Princess and Stripey.

Setting

All of the participating tigers were housed at the National Tiger Sanctuary in Saddlebrooke, Missouri. Princess, Precious, and Stripey were housed together, while the rest of the tigers were houses in their own enclosures. Enclosures at the Sanctuary range in size from 5,000 to 15,000 square feet. The Sanctuary is located on 130 acres of open land, only some of which is dedicated to the rescued animals. In addition to the tigers, there were dozens of other animals living at the Sanctuary, including 18 additional tigers, nine lions, four leopards, two mountain lions, one wolf, 11 wolf-hybrids, two lemurs, one alligator, two arctic foxes, two horses, one pig, one llama and one boa constrictor.

Preference Assessments

Free-operant preference assessments were completed for each of the tigers. There were three phases for each participant, five minutes in length, and each phase was recorded using partial-interval recording in five-second blocks (PI-5"). There were a total of 15 minutes of observation for each tiger; five minutes for each phase.

Three of the subjects, Princess, Precious and Stripey were tested together in each phase due to the fact they were in the same enclosure and the need to not stress the tigers out, therefore each of their phases was run slightly differently from the other four tigers.

Phase One

The first phase of assessments was used to identify the most highly preferred scent of two scents used for enrichment at the Sanctuary; Cinnamon and Calvin Klein's Obsession cologne. For convenience, pumpkins were used for this phase because they were plentiful during the time of year that Phase One took place and the tigers enjoy them. The trial consisted of two pumpkins

placed in the center of the enclosure with clear visual identification by the observer(s). One pumpkin with Obsession (S_1), and one with cinnamon (S_2). To be judged as "choosing" a scent, the tiger had to touch the pumpkin with its nose, tongue or paw. Simply smelling the pumpkin while standing above it did not count as an interaction. The most preferred scented pumpkin during phase one determined the scents used in Phase Two.

For the enclosure holding three tigers, there was a total of six pumpkins, three of each scent, so that each of the tigers had access to the same number of items as the individually-housed tigers.

Phase Two

The second phase consisted of three new enrichment items being presented at the same time using the preferred scent (S1, S2) chosen by each tiger in Phase One. The enrichment items were cardboard boxes (E1), a pile of leaves (E2), and a favorite toy (E3). Each tiger has a favorite toy in their enclosure. These range from 10 pound bowling balls to 75 pound hard plastic balls or other shapes, depending on the tiger and their degree of destructiveness. In Phase Two, each of the three enrichment items were placed in a center area of the tiger's enclosure.

As in Phase One, the enclosure holding three tigers included a total of six enrichment items. There were two scented items for each of the three tigers.

The stimuli were lined up in a row, where each could be observed easily by the observer(s) and had the scent chosen by the tiger in Phase One applied to it. For an interaction to count in this phase, 'interaction' was defined by the tiger touching the item with its nose, tongue or paw; simply smelling the item while standing above it did not count as a successful

interaction. The most frequently contacted item during the PI-5" observation period was the item considered 'chosen' by the tiger as their favorite.

Phase Three

In the third phase, the most highly preferred items were presented again using both scents as well as a non-scented item; to confirm that the scent from Phase One is indeed the most preferred, controlling for the smell of the pumpkin itself. In Phase Three, interaction was defined as 'having a paw, tongue, nose or any combination of that touching the object. As in the previous phases, simply standing over the object smelling but not interacting with it did not count.

For the enclosure consisting of three tigers, whichever enrichment items were chosen by each tiger, there were three of each of those items in the enclosure during phase three to cater to each tiger

Stimuli

There were several different types of stimuli used for this study; piles of leaves, balls, cardboard boxes and pumpkins. Each different item brought about its own set of challenges and routine. For the leaf piles, leaves were gathered that had already fallen off trees and were decaying, they were gathered with rakes and put into 55-gallon barrels. Once brought into an enclosure, the piles were made to be one foot high and three feet long. The balls that were used varied in size. The smaller, gentler tigers, such as Farah, Princess, Precious and Stripey, had 10-pound bowling balls, which were 8.5 inches in diameter. Carma had a 25-pound, 1 inch thick, hard plastic ball, Harry, had a 65-pound, 2 inch thick, hard plastic ball and Dakar had a 75-pound, 2.5 inch thick,

hard, plastic ball.

The cardboard boxes also varied in size, ranging in size from 16 inches x 12 inches x 12 inches to 24 inches x 18 inches x 24 inches. With respect to the cardboard boxes, the staff and researchers had to always ensure that all tape was completely removed from the boxes before they were placed into any enclosure. If not, the tape could become stuck the tiger's stomach and cause injury and/or death. Pumpkins were donated to the Sanctuary and ranged in size and weighed between 12 and 20 pounds. There are no safety hazards to a tiger when it comes to pumpkins other than when it begins to rot, so there were no extra safety precautions taken.

The space between stimuli in every phase depended on how big the enclosure was, however one determining factor was that all the stimuli needed to be able to be seen in one shot on the camera being used for recording. In most cases, stimuli were approximately three feet apart, in a line. In the enclosure with three tigers, there were always more than just one row of stimuli. In these cases, they were placed 3-4 feet apart in a line, with the second line two feet behind the first line, with each item, directly behind the item in front of it.

Setting up each assessment was a challenge, as we needed to do it as quickly but as efficiently as possible. Shifting the tigers between areas took between five and ten minutes depending on how cooperative that tiger was being. The enclosure then had to be cleaned, the items brought in, and the phase set up with scents (if needed in the current phase) put on the items as quickly as possible, so as not to stress out the tiger while it sat in its bedroom area, watching us in its enclosure. The goal was always to achieve this in 20 minutes or less.

Procedure

Data were taken from outside the tiger's enclosure with a fence separating the observer from the tiger. The sessions were videotaped by the researcher. The researcher was present for each phase to communicate which items and scents to include for each phase, as well as to take data on which item was interacted with the most and for what amount of time.

Each phase lasted for five minutes. The phase ended immediately if the tiger removed an item from the observation area and returned to their sleeping area. This resulted in the tiger being out of sight of the observer. There were never more than three people present during the time of observation; the researcher, at least one staff member, and someone to take pictures for the sanctuary. During the preparation for a phase, however, anywhere from three to six people were present. The number was depended on the size of the enclosure, the day and how long it had been since the enclosure had been entered.

To get an enrichment item into the enclosure, the tiger(s) always had to be in a different area than where the observation was going to take place, so they had to be moved. In order to do this, the tiger had to be lured into the bedroom area; usually with food or attention at the fence line next to their sleeping quarters. Once the tiger was safely in that area, a senior staff person had to use a series of tools and pulleys to shut the tiger into that area and lock them into it before unlocking the yard area. Staff and researchers would then enter the enclosure, clean the yard, ensure that enrichment items were placed accordingly, and do this as quickly as possible, so as not to stress out the tiger(s).

Once the enrichment item had been placed in the enclosure and the proper scent(s) put on the items, everyone left the enclosure so that the senior staff person could shift the tiger into the observation area, using the same pulleys and tools used to shift them into the bedroom area

previously. This step only occurred once everyone was away from the fence line. The tiger was then released into the observation area and the phase would begin.

Before the beginning of each phase, the enrichment items from the previous phase were removed so that only the items in the current phase are an option to be chosen and to ensure high levels of motivation to interact with each new item. All preference assessments were run between 12:00 and 6:00 pm each day, with the exact time determined by the staff at the Sanctuary.

Temperature and barometric pressure were recorded during each session as they can affect activity levels. Tigers are hypersensitive to weather and air pressure fluctuations, therefore, when a change in air pressure occurs, their behaviors are likely to change as well (Toothman, 2019).

Interobserver Agreement

Interobserver agreement was assessed by having a second observer watch 35% of the recorded experimental sessions. Records were compared on an interval-by-interval basis, and an agreement was scored on any interval in which both observers scored either the occurrence or nonoccurrence of behavior with respect to each item. Agreement percentages were calculated for each phase by dividing the number of agreement intervals by the number of agreements and disagreements and multiplying by 100%. Mean interobserver agreement scores were 97% (range, 96% to 100%), 98% (range, 97% to 100%), 98% (range, 98% to 100%), for Phase One, Phase Two, and Phase Three, respectively.

RESULTS

The data for the first subject, Harry, are shown in Figure 1. During Phase One, the barometric pressure was 30.28" Hg and the temperature was 34 degrees and clear. Harry interacted with cinnamon (42%) more than Obsession (20%). During Phase Two, the barometric pressure was 30.05" Hg and the temperature was 48 degrees and sunny; he interacted with the cardboard box with cinnamon the most, spending 95% of his observation time with it. Finally, during Phase Three, the barometric pressure was 29.95" Hg and the temperature was 64 degrees and clear; he interacted with the plain cardboard box for most (98%) of the observation period, to the exclusion of the other two. He seemed to prefer both scents when paired with pumpkins and the cinnamon-scented box in Phase Two, but the unscented cardboard box was the preferred enrichment item during Phase Three.

The data for the second subject, Dakar, are shown in Figure 2. During Phase One, the barometric pressure was 29.38" Hg and the temperature was 50 degrees and overcast, Dakar interacted the Obsession-scented pumpkin (22%), but not the cinnamon-scented pumpkin. During Phase Two, the barometric pressure was 30.36" Hg and the temperature was 32 degrees and icy; he interacted with the Obsession-scented plastic ball the most, spending 93% of his observation time with it. Finally, during Phase Three, the barometric pressure was 30.12" Hg and the temperature was 36 degrees and foggy; he interacted with the non-scented ball for most (75%) of the observation time and the obsession-scented ball 22% of the time.

The data for the third subject, Farah, are shown in Figure 3. During Phase One, the barometric pressure was 30.16" Hg and the temperature was 45 degrees and overcast, Farah interacted the Obsession-scented pumpkin (63%), but less so with the cinnamon-scented

pumpkin (3%). During Phase Two, the barometric pressure was 29.86" Hg and the temperature was 39 degrees and overcast; she interacted with the pile of leaves the most, spending 38% of her observation time with it and less time with the cardboard box (8%). Finally, during Phase Three, the barometric pressure was 29.55" Hg and the temperature was 64 degrees and sunny; she interacted with the cinnamon-scented leaf pile for most (72%) of the observation time and ignored the other two piles of leaves.

The data for the fourth subject, Carma, are shown in Figure 4. During Phase One, the barometric pressure was 30.08" Hg and the temperature was 54 degrees and overcast, Carma interacted the Obsession-scented pumpkin (60%), but not the cinnamon-scented pumpkin (2%). During Phase Two, the barometric temperature was 30.10" Hg and the temperature was 48 degrees and sunny; she interacted with the obsession-scented pile of leaves the most, spending 93% of her observation time with it and much less time with the other two enrichment items. Finally, during Phase Three, the barometric pressure was 30.03" Hg and the temperature was 59 degrees and overcast; she interacted with all three piles of leaves. The two scented leaf piles were interacted with the most (cinnamon – 47%; Obsession – 30%), while the unscented was mostly ignored 17%). The data suggest that Carma preferred the pile of leaves as her enrichment item, regardless of what scent was on them.

The last three subjects, Precious, Princess, and Stripey were tested together in the same enclosure and thus their phases were slightly different than the previous four subjects. In each phase, there were enough enrichment items for all three tigers. This was to done to reduce any stress that may have been caused by one of the tigers seeing an enrichment item but not being able to interact with it. The barometric pressure and temperature for all three tigers were the same for each phase: Phase One: the barometric pressure was 30.02" Hg and the temperature was

46 degrees and overcast, for Phase Two the barometric pressure was 30.02" Hg and the temperature was 63 degrees and sunny and finally, for Phase Three, the barometric pressure was 29.95" Hg and the temperature was 54 degrees and sunny.

The data for the fifth subject, Princess, are shown in Figure 6. During Phase One, Princess interacted with the Obsession-scented pumpkin, spending 53% of the observation time with one of the three Obsession scented pumpkins and less than 7% of her time with any of the cinnamon-scented pumpkins. During Phase Two, Princess interacted with three of the six enrichment items in the enclosure; the Obsession-scented pile of leaves (82%), the Obsession-scented box (13%), as well as the cinnamon scented box (3%). The Obsession scented pile of leaves was her most frequently chosen enrichment item. Finally, during Phase Three, Princess interacted with only two of the six items in her enclosure. She interacted with the Obsession-scented pile of leaves (97%) and the Obsession-scented cardboard box (3%). These results suggest that Princess preferred both the scent Obsession and a pile of leaves.

The data for the sixth subject, Precious, are shown in Figure 5. During Phase One, Precious interacted the most with the cinnamon-scented pumpkin, spending 62% of the observation time with one of the three cinnamon-scented pumpkins, she did not interact with any of the Obsession-scented pumpkins during Phase One. During Phase Two, Precious interacted with two of the six enrichment items in the enclosure, the Cinnamon box (2%) and the cinnamon scented pile of leaves (58%). She did not interact with anything scented with Obsession. Finally, during Phase Three, Precious interacted with all three of the cardboard boxes, but did not interact with any of the three piles of leaves. She interacted the most with the Obsession scented box (50%), followed by the cinnamon scented box (22%) and then the non-scented box (7%).

The data for the seventh subject, Stripey, are shown in Figure 7. During Phase One, Stripey interacted with the cinnamon-scented pumpkins the most, spending 70% of the observation time with one of the three cinnamon-scented pumpkins and 3% of her time with any of the Obsession-scented pumpkins. During Phase Two, Stripey interacted with all but one of the enrichment items. She interacted with the cinnamon-scented cardboard box the most (32%), followed by the cinnamon scented leaves (12%) and the Obsession scented box (12%). The two she interacted with the least were the cinnamon scented toy (8%) and the Obsession scented toy (5%). Finally, during Phase Three, Stripey interacted with two of the six items in her enclosure, the cinnamon scented pile of leaves (18%) and the unscented pile of leaves (13%).

DISCUSSION

This study sought to establish a hierarchy of enrichment items for seven tigers using olfactory stimuli (Obsession and cinnamon) and familiar play items. Most of the seven tigers showed a preference for one of the olfactory stimuli during Phase One. Some did so clearly, while others were less interested in either scent in Phase One (Harry and Dakar). The scents were applied to pumpkins, with their own smell, so it is possible that it was some *combination* of scents that were most salient during this phase. Pumpkins were used during Phase One due to their ubiquity during the time of year the study was completed, and the fact that trainers indicated that the scents were important to the cats and necessary for enrichment. The staff had always scented play items and felt strongly that this was a necessary procedure. Obviously, pumpkins have a scent of their own and this likely interacted with the Obsession and/or cinnamon. Another drawback of pumpkins was that they are available for a limited time and could not then be used during the latter two phases.

During Phase Two, the preferred scent from Phase One was applied to three of the tiger's favorite enrichment items. The items themselves were specific to each tiger and ranged from bowling balls to piles of leaves. Six out of seven tigers showed a strong preference for one of the available enrichment items during Phase Two. Stripey interacted with most of the items to some degree although she interacted most with the cinnamon-scented cardboard box. For some of the tigers, a pile of leaves was an enrichment item that, like pumpkins, has a scent of its own and is available for a limited time each year.

During Phase Three, three of the most-preferred items from Phase Two were used as enrichment items and scent was reintroduced as a component of the assessment. One item had

cinnamon applied to it, the second item had Obsession, and the third was left unscented. This phase was used to confirm that the scent from Phase One and item from Phase Two were, in fact, most preferred items. Harry preferred cinnamon (although not by much) during Phase One, but very clearly preferred the cardboard box without either Obsession or cinnamon applied to it. For Harry, destroying cardboard boxes is a favorite activity and the additional scents were not needed. Of course, cardboard, like leaves and pumpkins, also has a scent of its own. It's likely that for Harry, cardboard boxes alone, without additional scents, is a most-preferred enrichment item. In this case, the sanctuary could eliminate scenting cardboard boxes in the future without decreasing their effectiveness for Harry.

Dakar showed some preference for Obsession during Phase One, but not a lot (22%). During Phase Three he preferred the ball without a scent added but he also spent time with the ball with Obsession applied. There is evidence that he enjoys Obsession as a scent, which is likely why he also interacted with the Obsession-scented ball as well.

Farah showed a strong preference for Obsession during Phase One, but spent most of her time in Phase Three interacting with the pile of leaves that had no added scent. It seems likely that the natural scent of decaying leaves was much preferred over the other two scents. In this case, the sanctuary could eliminate scenting piles of leaves in the future without decreasing their effectiveness for Farah.

Carma showed a strong preference for the pumpkin with Obsession on it during Phase One. During Phase Three, she played in all three piles of leaves to some degree. Carma was a very active tiger and enjoyed playing in piles of leaves. She was also a very friendly cat, and anecdotally, it seemed that as the observer moved around, she followed and played in whichever

pile of leaves was closest to the observer. Thus, for Carma the presence of a human was a highly preferred enrichment item.

Princess showed a strong preference for Obsession on pumpkins during Phase One and Obsession on leaves during Phase Two and Phase Three. Princess was the only tiger out of seven who chose a scent and an enrichment item that were her favorite and stayed with them through the study.

Precious showed a strong preference for cinnamon on pumpkins during Phase One, but played with all three cardboard boxes during Phase Three to some degree. During Phase Two, she only played with the pile of leaves with cinnamon on them. It's possible that the leaves smelled different from week to week, but that is unknown. She clearly preferred the cardboard boxes in Phase Three instead of the leaves. Precious is a friendly cat who prefers human attention, and the cardboard boxes were all close to the fence line where humans would stand. This may be why she chose the boxes as she rubbed against the fence many times during this phase.

Stripey showed a strong preference for cinnamon on pumpkins during Phase One. During Phases Two and Three, she showed some interest in the cinnamon-scented items, but not a lot of interest, overall. Stripey is an older, docile cat who prefers privacy, while she enjoys enrichment, she also is in retirement and enjoys relaxing more than anything. Since she had to be tested with Princess and Precious, she probably wanted to just let them play and she played at a later time, as she is the least dominant cat in that enclosure.

Before beginning the study, the trainers at the sanctuary indicated that scents like Obsession and cinnamon were very important to the tigers and their use of enrichment items. The results of this assessment indicate that some of the tigers had a strong scent preference (Princess,

Precious and Dakar) and others did not (Harry, Farah, Carma, and Stripey). Both pumpkins and leaves have their own scent which makes analysis of the two targeted scents (Obsession and cinnamon) more difficult. Cardboard boxes also have a scent that could have impacted the tiger's selections of most-preferred items.

The enclosure that housed three tigers (Princess, Precious and Stripey) necessarily complicated assessment procedures during this study. The procedure had to be altered slightly for these tigers. First, we had to include more enrichment items in each phase. Second, we had to ensure that each of the tigers had the full five minutes of observation time. Third, extra staff were required during their assessments to ensure the safety of the tigers if a fight began over the enrichment items.

The three-tiger group also effected the results, particularly in Stripey's case. If she had been in an enclosure by herself, she may have been more engaged and interacted more with the enrichment items during the observation periods. These three tigers have always been housed together and separating them for the assessments would have been very difficult and would be more stressful than necessary for the tigers. The interaction of the triad of tigers was interesting in itself. They each have their role and status in the group and that may have effected their behavior during the assessments. For example, while Precious approached Stripey during Phase three intermittently, neither Stripey nor Precious ever approached Princess or her pile of leaves or her pumpkin. Princess was the dominant cat and that is something less dominant animals don't do. So, while scent can be a strong determinant of animal behavior, it is not the only determinant of what enrichment items are interacted with and when.

Limitations

There were several limitations to this study. First, we could run only one assessment session with a cat (or group of cats) each week. In order to begin a session, we had to move the tiger to the area where the assessment was not going to be taking place before the enrichment could be placed into the enclosure. For most of the cats, this was the bedroom area. This requires multiple staff, including a senior staff, a series of pulleys and tools as well as speed and training to always be aware of our surroundings and where the cat is at all times. The process of moving them and the presence of humans in their enclosure would agitate the cats and therefore was kept to a minimum. Further, the process of assessment required the presence of staff and trainers and there were dozens of other rescued wild animals to be cared for as well. Second, the sample size was small and the individual tigers themselves had idiosyncratic histories of abuse and neglect. This makes it difficult to generalize the findings to other tigers. Third, the procedure was relatively rigid and could not be altered as needed during assessments. There were many safety precautions in place and all materials had to be in place before a phase began. We were not able to stop a session mid-way to make any changes. Anything that involved a human entering the enclosure required many proscribed steps, making the whole assessment process very strict. At best, any change would necessitate waiting another week and running the session. Finally, the array of enrichment items available to us was limited. Many enrichment items were expensive and difficult to attain. Any item had to be 1) safe for the tiger to interact with and 2) very robust as well. Tigers can effortlessly bite through bowling balls and often do, so stimulus selection was limited.

Future Research

Future research should incorporate a larger study group with a more even male to female ratio would be helpful for more accurate answers as to personality differences. Maybe the males are more aggressive and possessive as a gender than the females? Having a larger variety of 'tiger-safe' scents, such as other spices would be good to include in future research, perhaps only having two scents was not enticing enough to the tigers. Bigger, more interesting 'tiger-safe' toys would be good for future research as well. This may make the tigers want to interact with the toys more than what is already in their enclosure or a cardboard box.

Implications

Tigers, as a species, are in grave danger of becoming extinct within the next decade according to some scientists. These are important animals not only because of their beauty and awe for humans but what they bring to the world. Tigers are apex predators, meaning they have no natural predators of their own and they keep natural prey populations under control. If tigers go extinct, their prey will become overpopulated and what that animal eats will be overeaten, causing the entire food chain to go awry (Dotson, 2018). Tigers are worth more in the wild than they are for a trophy, rehabilitation should be our number one goal and that starts with the protection of the wild tigers we still can protect, as well as the preservation of the mental health and the improved happiness of the captive tigers we have now.

Improving the mental health of captive tigers is something that could be done easily with the help of zookeepers and behavior analysts coming together. With the possibility of the extinction of a species on the line, it should be a goal to make healthy, happy tigers to rehabilitee into the wild. Happy tigers are more likely to raise more healthy cubs as they, themselves will be healthier. Happier tigers may be more willing to reproduce, hunt and get back into the routine of

what a tiger should be doing. Like humans, stress takes a toll on all parts of the body, physically, emotionally, and behaviorally.

More frequent assessments should be run on not only tigers, but any captive wild animals, where the goal is eventual release back into the wild. Keeping track of the mental, physical and emotional stability of these animals will give us a better idea of what to expect from this species. Every species of animal deserves an opportunity, and as humans, it is our responsibility to fight for the things that cannot fight for themselves. In these situations, where animals have been hunted or driven out of their homes due to destruction of their habitats, it is our responsibility to help them back up, to give them a fighting chance. The population of tigers was at its lowest in the year 2007, at 1,400 it's now back up to 3,800 (Hemley, 2019). This shows there is hope, with the proper dedication, assessments, enrichment and research, we can keep tigers from extinction.

REFERENCES

Carlstead, K. (1996) Effects of captivity on the behavior of wild mammals. In: *Wild Mammals in Captivity: Principles and Techniques* (eds D.G. Kleiman, M. Allen, K.Thompson, S. Lumpkin and H. Harris). University of Chicago Press, Chicago, 317-333.

Dotson, J. (2018). The Role of Tigers in the EcoSystem. Retrieved from https://sciencing.com/role-tigers-ecosystem-7638501.html

Ellis, J. J., Stryhn, H., Spears, J., & Cockram, M. S. (2017). Environmental enrichment choices of shelter cats. *Behavioural Processes*, 141, 291–296. https://doi-org.proxy.missouristate.edu/10.1016/j.beproc.2017.03.023

Ellis, J. J. (2013). Effects of environmental enrichment and behavioral style on stress responses in singley housed shelter cats. PhD. Thesis. University of Prince Edward Island, Charlottetown, Canada.

Fernandez, E. J., Dorey, N. R., & Rosales-Ruiz, J. (2004). A Two-choice preference assessment with five cotton-top tamarins (Saguinus oedipus*). Journal of Applied Animal Welfare Science,* 7(3), 163–169. https://doi org.proxy.missouristate.edu/10.1207/s15327604jaws0703_2

Fudge, E. 2005. Introduction: Viewing Animals. Worldviews: Global Religions. *Culture & Ecology*, *9*(2), 155–165. doi- 10.1163/1568535054615330

Gilbert, T., Gardner, R., Kraaijeveld, A. R., & Riordan, P. (2017). Contributions of zoos and aquariums to reintroductions: historical reintroduction efforts in the context of changing conservation perspectives. *International Zoo Yearbook*, *51*(1), 15–31. doi:10.1111/izy.12159

Goodrich, J., Lynam, A., Miquelle, D., Wibisono, H., Kawanishi, K., Pattanavibool, A., Htun, S., Tempa, T., Karki, J., Jhala, Y. & Karanth, U. (2015). Panthera tigris. The IUCN Red List of Threatened Species 2015: e.T15955A50659951.

Hemley, G. (2019). Tigers. Retrieved from https://www.worldwildlife.org/species/tiger.

Karmacharya, D., Sherchan, A. M., Dulal, S., Manandhar, P., Manandhar, S., Joshi, J., . . . Hughes, J. (2018). Species, sex and geo-location identification of seized tiger (Panthera tigris tigris) parts in Nepal—A molecular forensic approach. *Plos One*, 13(8). doi:10.1371/journal.pone.0201639

Maia, C. M., & Volpato, G. L. (2018). Correction: Preference index supported by motivation tests in Nile tilapia. *Plos One*, 13(1). doi:10.1371/journal.pone.0192283

Mehrkam, L. R., & Dorey, N. R. (2014). Is preference a predictor of enrichment efficacy in Galapagos tortoises (*Chelonoidis, nigra*)? *Zoo Biology*, *33*, 275-284. https://doi.org/10.1002/zoo.21151

Mehrkam, L. R., & Forey, N. R. (2015). Preference assessments in the zoo: Keep and staff predictions of enrichment preferences across species. *Zoo Biology*, *34*, 418-430. doi: 10.1002/zoo.21227

Makecha, R. N., & Highfill, L. E. (2018). Environmental Enrichment, Marine Mammals, and Animal Welfare: A Brief Review. *Aquatic Mammals*, *44*(2), 221–230. doi: 10.1578/AM.44.2.2018.221

Márquez-Arias, A., Santillán-Doherty, A. M., Arenas-Rosas, R. V., Gasca-Matías, M. P., & Muñoz-Delgado, J. (2010). Environmental enrichment for captive stumptail macaques (Macaca arctoides). *Journal of Medical Primatology*, *39*(1), 32–40. doi: 10.1111/j.1600-0684.2009.00392

Mellen J D, Stevens V J and Markowits H. (1981). Environmental enrichment for servals, Indian elephants and Canadian otters at Washington Park Zoo, Portland. *International Zoo Yearbook* 21: 361-371. https://doi.org/10.1111/j.1748-1090.1981.tb01981

Mench, J. A., & Kreger, M. D. (1996). Ethical and welfare issues associated with keeping wild mammals in captivity. In: *Wild mammals in captivity: principles and techniques*. (eds Kleiman DG, Allen ME, Thompson KV, Lumpkin S.) Chicago Illinois: The University of Chicago Press, Chicago, 5-15.

Parnell, T., Narayan, E. J., Magrath, M. J., Roe, S., Clark, G., Nicolson, V., … Hero, J. M. (2014). Evaluating physiological stress in Sumatran tigers (Panthera tigris ssp. sumatrae) managed in Australian zoos. *Conservation physiology*, 2(1), cou038. doi:10.1093/conphys/cou038

Powell DM. (1995). Preliminary evaluation of environmental enrichment techniques for African lions (Panthera leo) *Animal Welfare* 4:361-370.

Ringdahl JE, Vollmer TR, Marcus BA, Roane HS. (1997). An analogue evaluation of environmental enrichment: the role of stimulus preference. *Journal of Applied Behavior Analysis*, *30*, 203-216. doi: 10.1901/jaba.1997.30-203

Shepherson DJ. (1998). Tracing the path for environmental enrichment in zoos. In: *Second nature: environmental enrichment for captive animals. Smithsonian Institution Press.* (Eds Shepherdson DJ, Mellen JD, Hutchins M.) Washington, 1-12.

Shreve, K. R., Mehrkam, L. R., & Udell, M. A. (2017). Social interaction, food, scent or toys? A formal assessment of domestic pet and shelter cat (Felis silvestris catus) preferences. *Behavioural Processes,* 141, 322-328. doi:10.1016/j.beproc.2017.03.016

Soso, S., Koziel, J., Johnson, A., Lee, Y., & Fairbanks, W. (2014). Analytical Methods for Chemical and Sensory Characterization of Scent-Markings in Large Wild Mammals: A Review. *Sensors,* 14(3), 4428-4465. doi:10.3390/s140304428

Toothman, J. (2019). Can Animals Predict the Weather? Retrieved from https://science.howstuffworks.com/nature/climate-weather/storms/animals-predict-weather2.htm.

Vaz, J., Narayan, E. J., Kumar, R. D., Thenmozhi, K., Thiyagesan, K., & Baskaran, N. (2017). Prevalence and determinants of stereotypic behaviours and physiological stress among tigers and leopards in Indian zoos. *Plos One,* 12(4). doi:10.1371/journal.pone.0174711

TABLES

Barometric / Temperature Table

Name	Phase 1	Phase 2	Phase 3
Harry	34° - clear	64° - clear	48° - sunny
	30.28" Hg	29.95" Hg	30.05" Hg
Dakar	50° - overcast	32° - icy/ foggy	36° - foggy
	29.38" Hg	30.36" Hg	30.12" Hg
Farah	45° - overcast	39° - overcast	64° - sunny
	30.16" Hg	29.86" Hg	29.55" Hg
Carma	54° - overcast	48° - sunny	59° - overcast
	30.08" Hg	30.10" Hg	30.03" Hg
Princess, Precious,	46° - overcast	63° - sunny	54° - sunny
Stripey	30.20" Hg"	30.02" Hg	29.95" Hg

Table 1

FIGURES

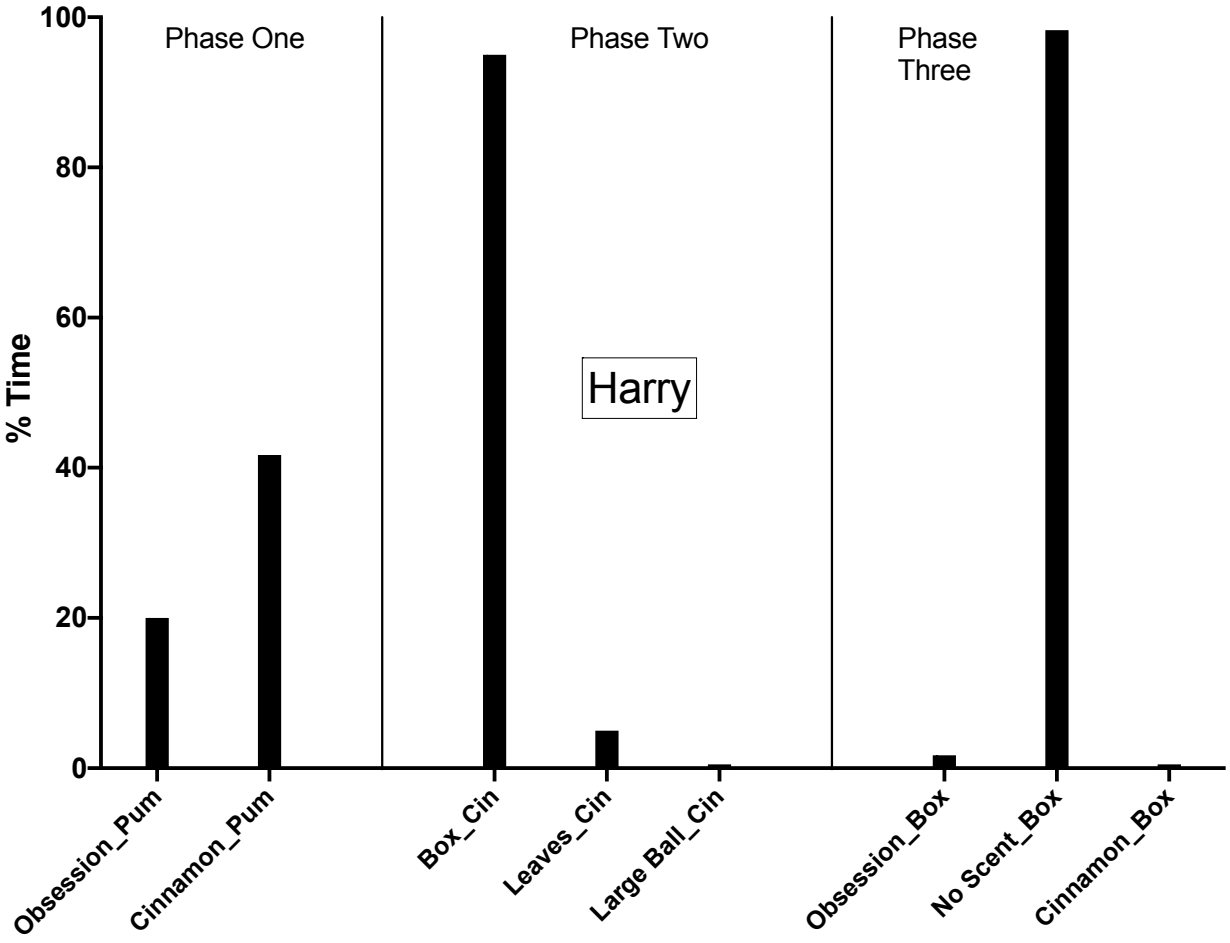

Figure 1

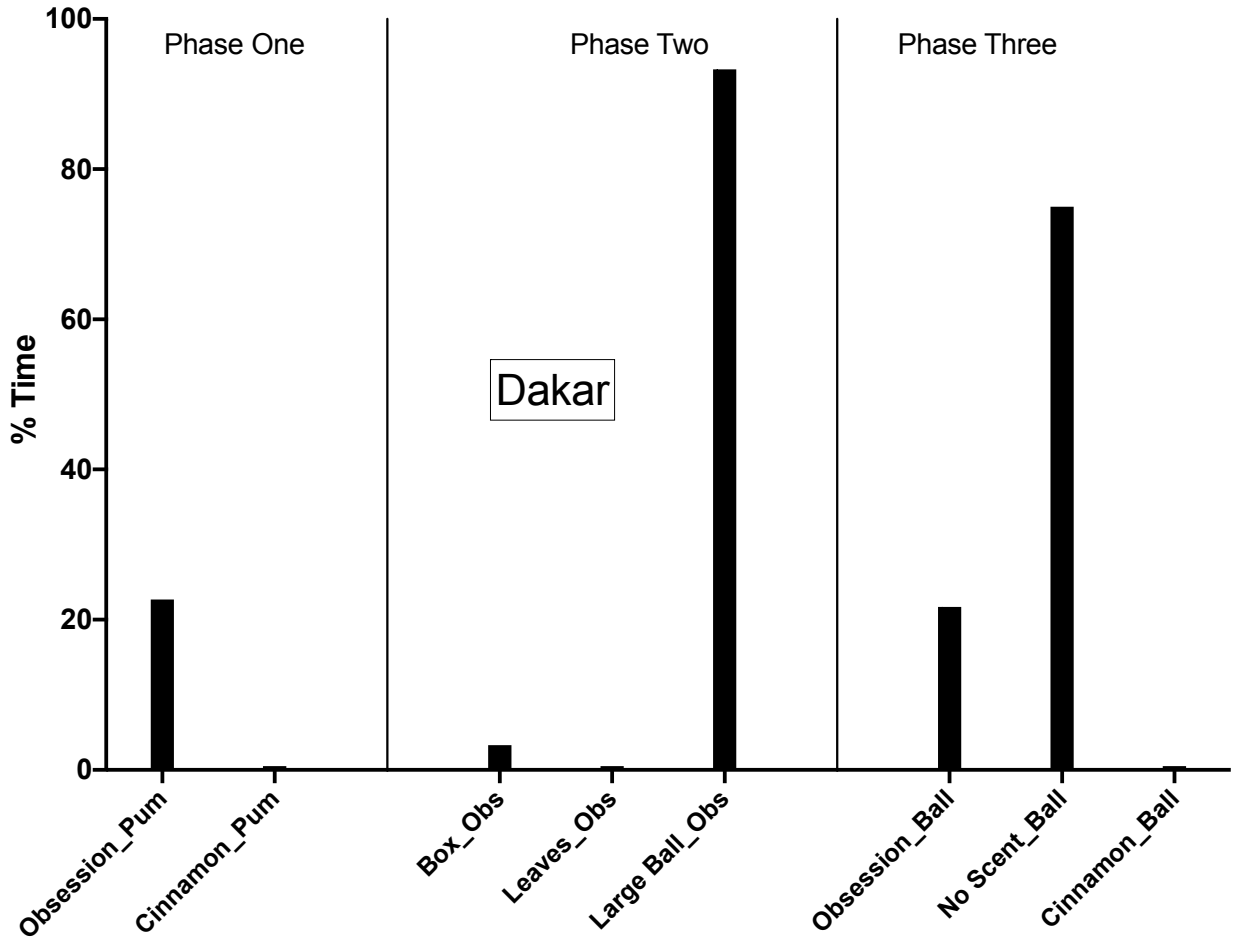
Phase One
Phase Two
Phase Three
Dakar
% Time
100
80
60
40
20
0
Obsession_Pum
Cinnamon_Pum
Box_Obs
Leaves_Obs
Large Ball_Obs
Obsession_Ball
No Scent_Ball
Cinnamon_Ball

Figure 2

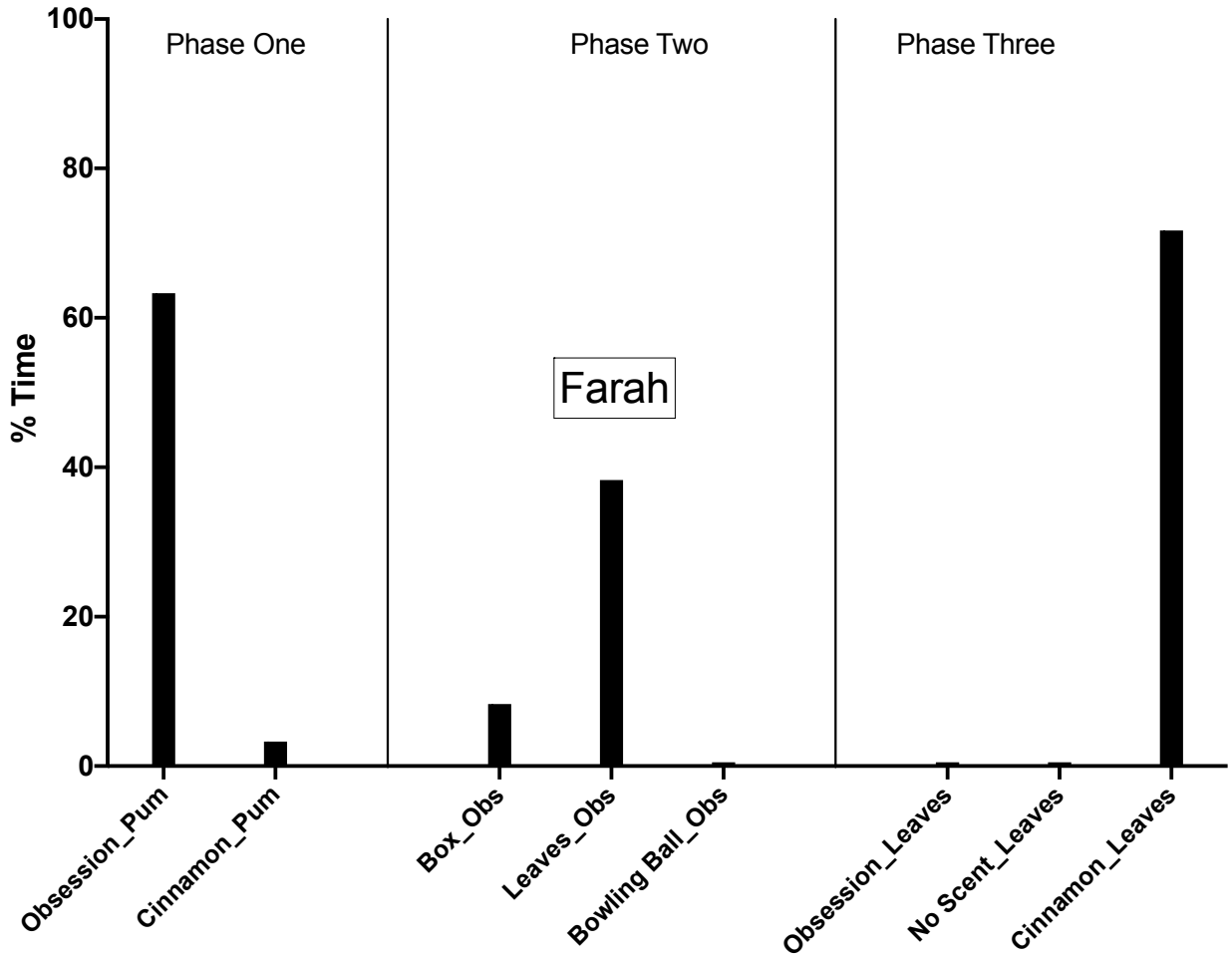
Phase One
Phase Two
Phase Three
Farah
% Time
100
80
60
40
20
0
Obsession_Pum
Cinnamon_Pum
Box_Obs
Leaves_Obs
Bowling Ball_Obs
Obsession_Leaves
No Scent_Leaves
Cinnamon_Leaves

Figure 3

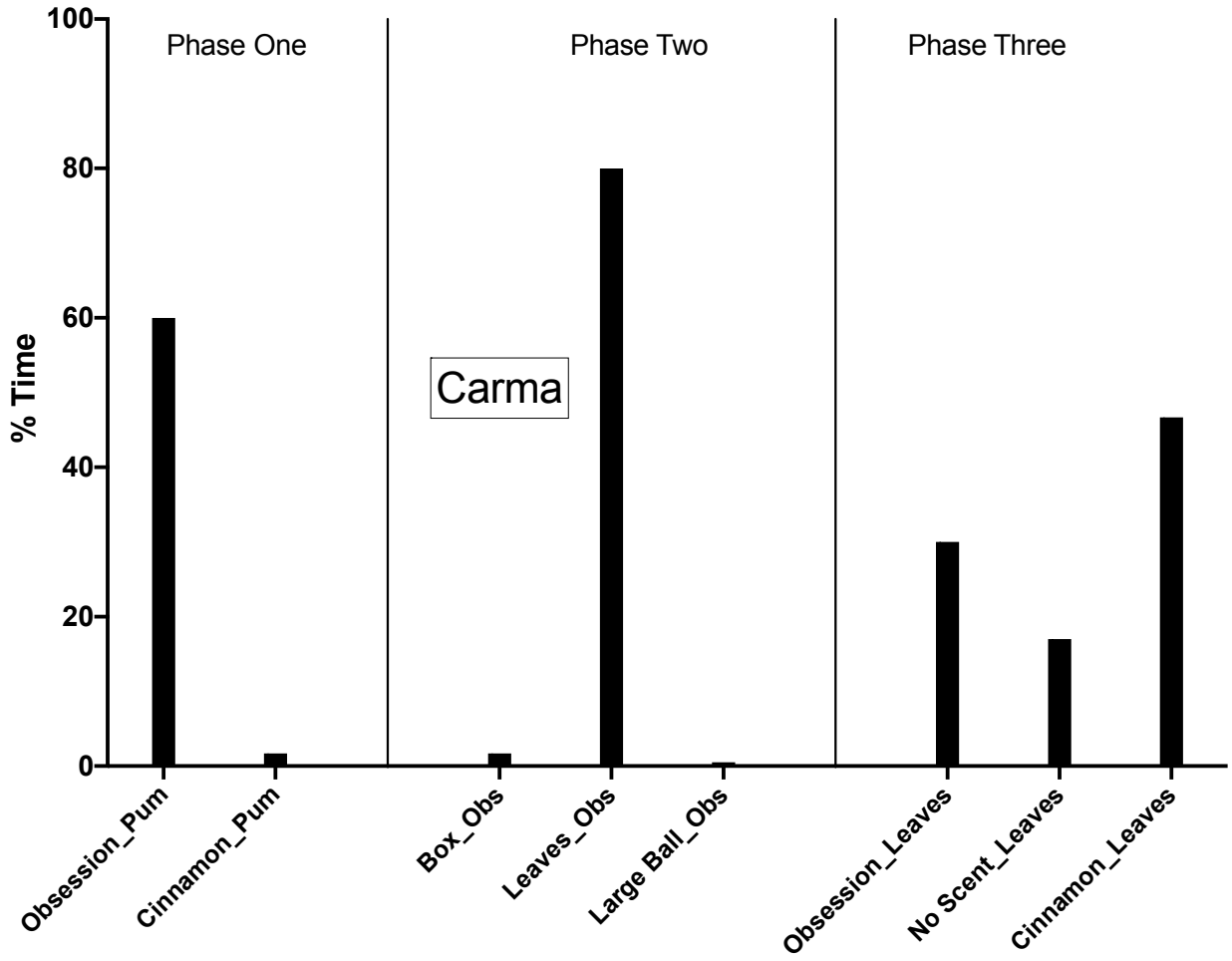
Phase One
Phase Two
Phase Three
Carma
% Time
100
80
60
40
20
0
Obsession_Pum
Cinnamon_Pum
Box_Obs
Leaves_Obs
Large Ball_Obs
Obsession_Leaves
No Scent_Leaves
Cinnamon_Leaves

Figure 4

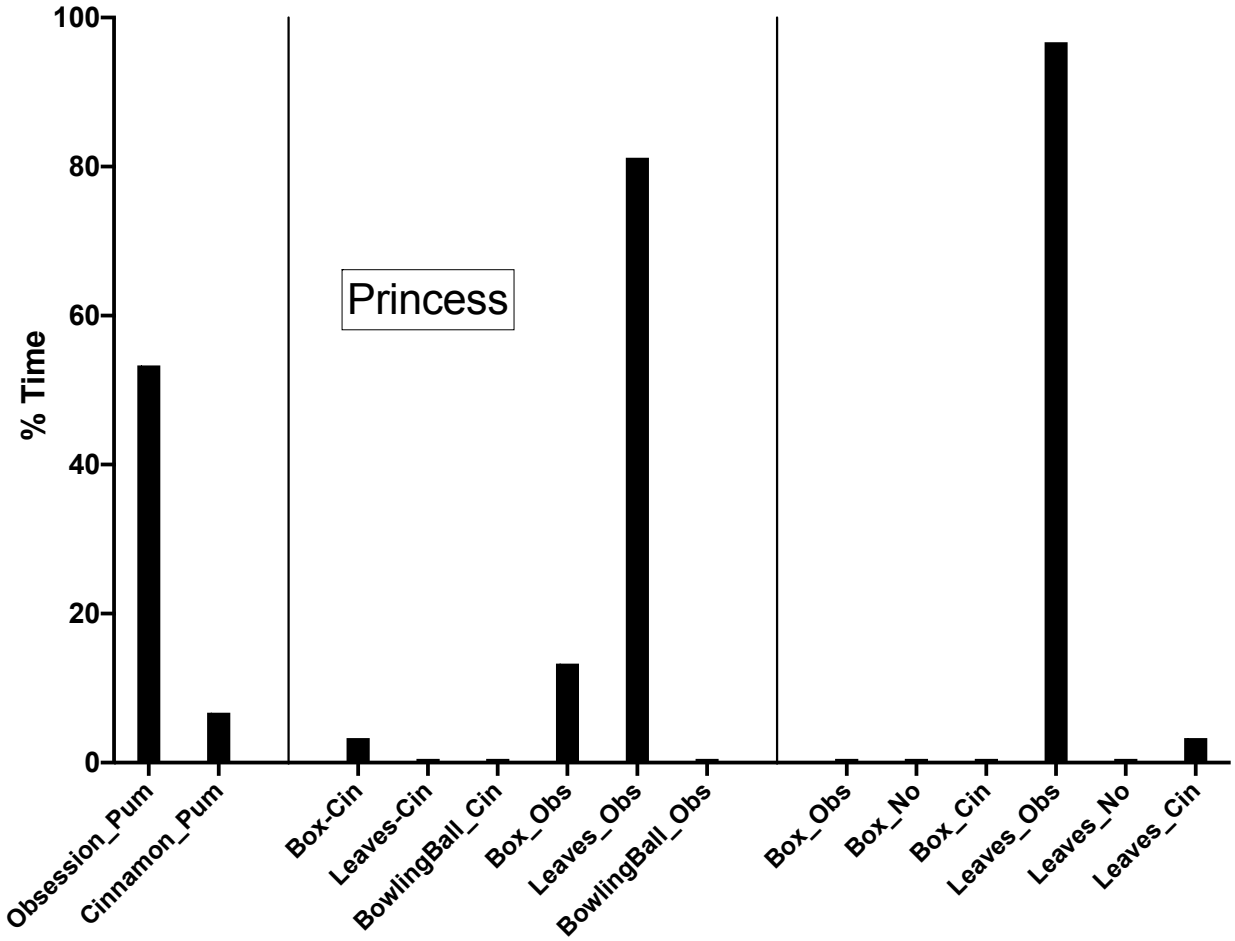
100
80
60
40
20
0
% Time
Princess
Obsession_Pum
Cinnamon_Pum
Box-Cin
Leaves-Cin
BowlingBall_Cin
Box_Obs
Leaves_Obs
BowlingBall_Obs
Box_Obs
Box_No
Box_Cin
Leaves_Obs
Leaves_No
Leaves_Cin

Figure 5

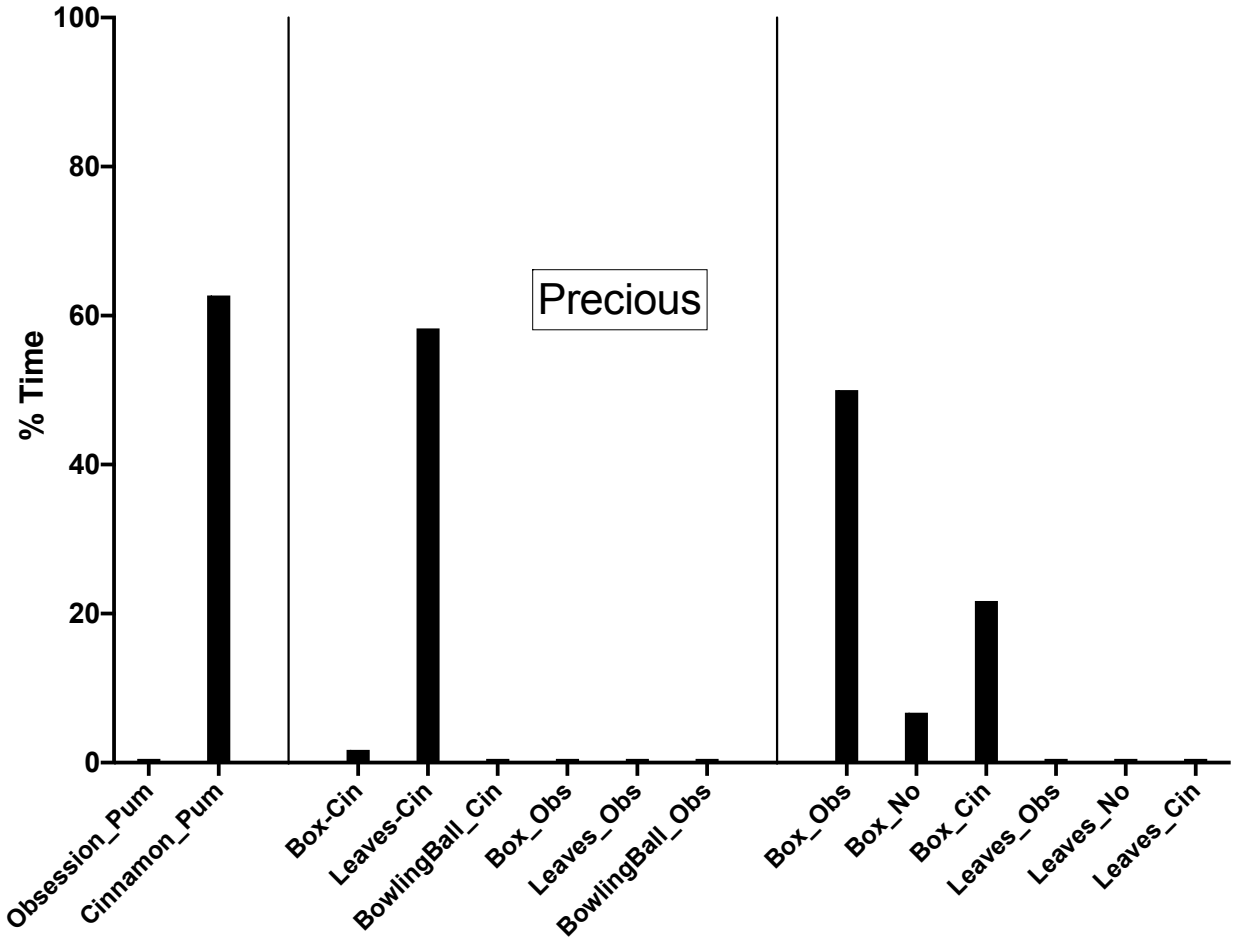
100
80
60
40
20
0
% Time
Precious
Obsession_Pum
Cinnamon_Pum
Box-Cin
Leaves-Cin
BowlingBall_Cin
Box_Obs
Leaves_Obs
BowlingBall_Obs
Box_Obs
Box_No
Box_Cin
Leaves_Obs
Leaves_No
Leaves_Cin

Figure 6

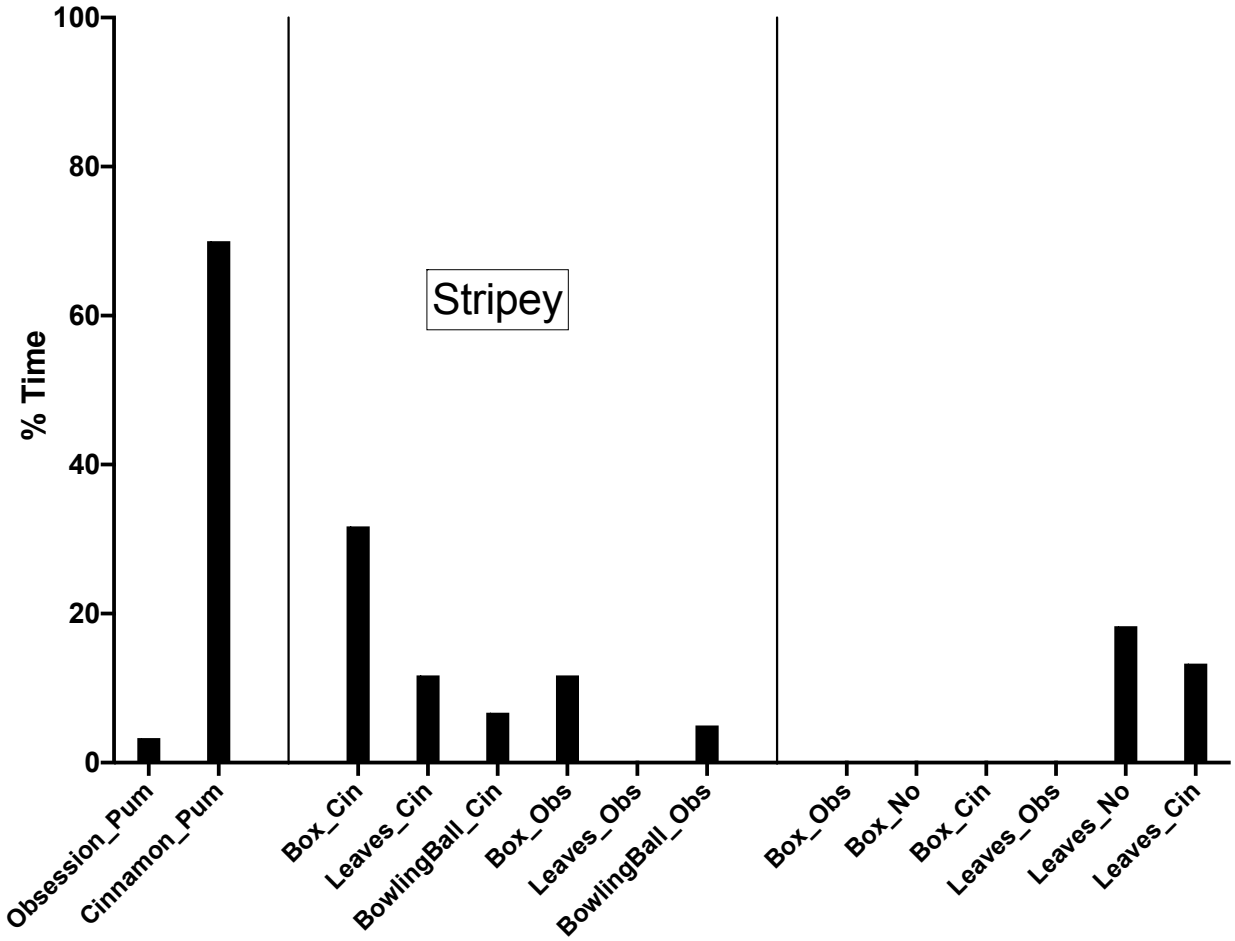
100
80
60
40
20
0
% Time
Stripey
Obsession_Pum
Cinnamon_Pum
Box_Cin
Leaves_Cin
BowlingBall_Cin
Box_Obs
Leaves_Obs
BowlingBall_Obs
Box_Obs
Box_No
Box_Cin
Leaves_Obs
Leaves_No
Leaves_Cin

Figure 7